Operative Versus Nonoperative Management of Acute High-Grade Acromioclavicular Dislocations: A Systematic Review and Meta-Analysis

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Objectives: Management of high-grade acromioclavicular (AC) joint dislocations has been controversial. Recent studies suggest no difference in outcomes between operative and nonoperative management of Rockwood types III–V injuries. The objective of this meta-analysis is to compare outcomes between operative and nonoperative management of high-grade AC joint dislocations.

Data Sources: Search was conducted using PubMed, Embase, and Cochrane databases through October 2016. A broad search strategy was used to identify English, comparative studies of AC joint dislocations.

Study Selection: Inclusion criteria included comparative studies of AC joint dislocations in adult patients with acute, high-grade AC dislocations.

Data Extraction: Two authors independently reviewed and assessed for bias according to the U.S. Preventative Task Force Quality Rating Criteria. Data were extracted for validated functional scores, clinical and radiographic outcomes, and complications.

Data Synthesis: Nineteen studies (n = 954) were included in the meta-analysis. Operative group had better cosmetic outcome (odds ratio [OR] = 0.05; $P < 0.00001$) and radiographic reduction (OR = 24.94; $P < 0.0001$). Constant scores favored the operative group, although the difference may not be clinically significant (MD = 3.14; $P = 0.03$). Nonoperative treatment was associated with faster return to work (MD = 4.17, $P < 0.0001$), lower implant complications (OR = 7.19, $P < 0.0001$), and reduced infection rate (OR = 3.65, $P = 0.007$). No difference was found for DASH Score, return to sport, radiologic evidence of osteoarthritis, and need for surgery after failed management.

Conclusions: No clinical difference in functional outcome scores was detected between operative and nonoperative management of high-grade AC joint dislocations. Patients in the nonoperative cohort had a more rapid return to work, but were associated with a poorer cosmetic outcome.

Key Words: acromioclavicular, dislocation, systematic review, meta-analysis

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

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INTRODUCTION

Management of acromioclavicular (AC) joint dislocations has been an ongoing subject of controversy.[1,2] The Rockwood classification of AC joint dislocations has been used to help determine between nonoperative and operative management.[3] Traditionally, Rockwood types I and II have been treated nonoperatively, whereas types IV–VI have been treated surgically.[2,4] There is no consensus on management of type IIIs.

However, recent evidence has shown that high-grade injuries can be treated nonoperatively with equivalent outcomes.[5–7] A randomized control trial conducted by the Canadian Orthopaedic Trauma Society suggested that there is no clinical difference in outcomes between surgical and nonoperative managements of high-grade AC joint dislocations.[5] Fremery et al have also determined that at 3 months of follow-up, patients with high-grade injuries who were treated nonoperatively had less pain, better range of motion, and earlier return to work.[6]

In addition, the inter- and intra-observer reliability of the Rockwood classification is poor, particularly when differentiating between type IIIs, IVs, and Vs.[8–10] Anatomically, types III–Vs all involve disruption of the AC and coracoclavicular ligaments.[3,10]

Three systematic reviews have previously focused only on type III injuries.[11–13] However, a number of recent randomized control trials have since been published that group all type III–Vs as a single cohort. The primary objective of this meta-analysis was to compare functional, clinical, and radiographic outcomes between operative and nonoperative management of acute high-grade (III–V) AC joint dislocations in adults.

METHODOLOGY

This systematic review and meta-analysis were conducted according to the PRISMA checklist.[14]

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Eligibility Criteria

Cohort or randomized control trials that compared nonoperative and operative outcomes of acute high-grade AC joint dislocations were selected. For this review, we considered all Rockwood types III–V, Allman types 2–3, and Tossy IIIs as high-grade injuries. Acute, isolated injuries in adults were included. All methods of surgical and nonoperative treatments were included in the analysis. A selected study must have reported at least 1 outcome of interest and a minimum follow-up of 12 months. Studies that did not directly compare operative and nonoperative outcomes were excluded. Chronic injuries, biomechanical, cadaveric, and animal studies were excluded. Non-English studies were excluded.

Search

A literature search for eligible studies was conducted on October 13, 2016. A broad-based search was performed to ensure studies would not be missed. Studies were searched using the MEDLINE, Embase, and Cochrane databases. Two highly sensitive and validated search strategies were used to identify cohort and randomized control trials.[15,16] MESH terms ("Acromioclavicular Joint") with Boolean operators were used ("Acromioclavic* OR Acromio Clavicular OR AC joint"). Duplicate studies were removed.

Study Selection

The search results were reviewed independently by 2 authors (A.K. and N.C.). Studies were screened by title and abstract. Full texts of the articles were obtained and reviewed independently by both authors using the predetermined inclusion and exclusion criteria. Any discrepancy in the final list of studies to be included was agreed on by the authors. Reference lists were reviewed for additional studies.

Data Extraction

Data were extracted by one author (A.K.). Two databases were created. One database contained study characteristics, such as study design, patient demographics, type of operative intervention, and follow-up. A second database collected all the outcomes of interest. Data from supplemental online appendices were also retrieved. Another author (N.C.) verified the contents of the databases.

Outcomes of Interest

Outcomes of interest included functional scores, objective clinical outcomes, radiographic findings, and complications. Only validated functional scores were included in the meta-analysis (Constant Score and DASH). Clinical outcomes included the Visual Analog Score, time to return to work, return to sport, and time to pain-free status. Radiographic outcomes collected included evidence of osteoarthritis, coracoclavicular distance, and radiographic joint reduction. Complications included poor cosmetic outcome, need for surgery after failure of operative or nonoperative treatment, implant complications, and infection.

Assessment of Bias

The U.S. Preventative Services Task Force (USPSTF) Quality Rating Criteria for Randomized Control Trials and Cohort Trials were used to assess the included studies for bias (see **Figure**, **Supplemental Digital Content 1**, http://links.lww.com/JOT/A152, for the assessment of bias chart). Each study was independently appraised by 2 authors (A.K. and N.C.), and assigned a grade (poor, fair, or good) in each predetermined category. The appraisals were combined, and any discrepancy was resolved with a thorough discussion between the reviewers.

Study Synthesis

Meta-analyses were performed using Review Manager software (RevMAN v5.3, Version 5.3, Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014). Dichotomous outcomes were expressed by odds ratios (ORs). For outcomes with continuous variables, the mean difference (MD) was calculated. When not explicitly expressed, SDs were estimated by a study's mean and range. In all analyses, 95% confidence intervals (CIs) were calculated, and *P* values less than 0.05 were considered statistically significant. As the 2 comparative studies reported by Natera et al used the same nonoperative cohort, the outcome data of the 2 operative groups were combined into 1 operative cohort. A subgroup analysis of randomized control trials was performed for the Constant Score outcome. A second subgroup analysis compared studies with isolated Rockwood type III injuries to studies with Rockwood type III–V or equivalent injuries. Given the variety of operative methods described, a third subgroup analysis was performed to compare individual operative techniques.

Heterogeneity between comparative studies was initially assessed using visual assessment. Further analysis was conducted using the χ^2 and I^2 statistics. Outcomes were estimated with a random effects model. This enabled equal weighting of studies, and potential causes for significant heterogeneity were considered.

RESULTS

Study Selection

A total of 1090 nonduplicate citations were found (Fig. 1). Sixty articles remained after a title and abstract screen. Full texts were screened using the predetermined inclusion and exclusion criteria. Two additional studies were identified from relevant reference lists, but one was excluded from the meta-analysis because it did not contain any outcome of interest.[17,18] Nineteen articles were selected for the meta-analysis. As demonstrated by the funnel plot for the Constant Score, no significant evidence of publication bias was found (see **Figure**, **Supplemental Digital Content 2**, http://links.lww.com/JOT/A153, for the Constant Score funnel plot).

Study Characteristics

A total of 954 patients were included in this review (Table 1). Five hundred seven patients underwent operative management, whereas 447 patients had nonoperative management. There were a total of 5 randomized control trials and 14

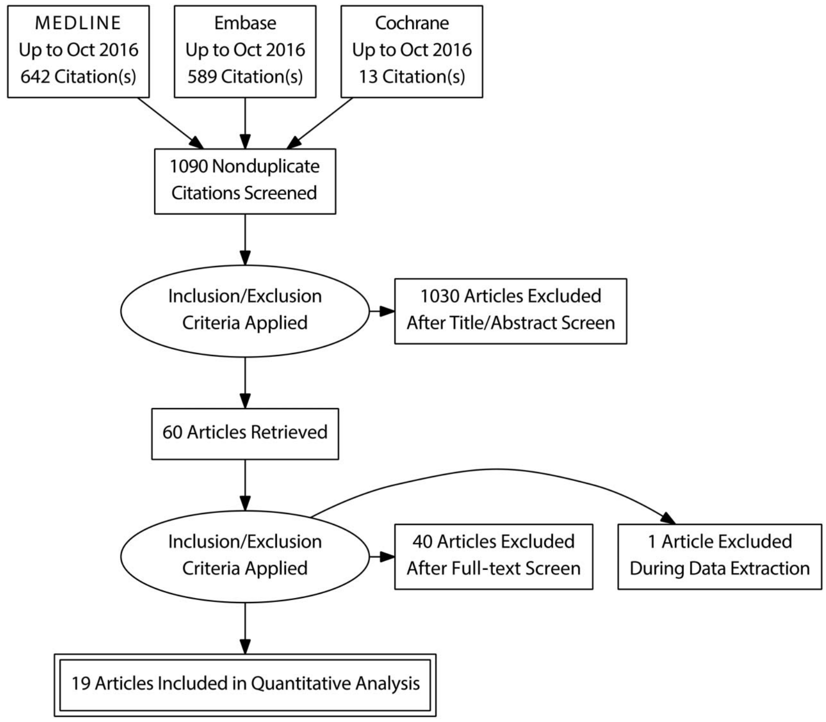

FIGURE 1. PRISMA flow chart demonstrating the search strategy used.

cohort studies. Most studies classified their injuries based on the Rockwood classification.[3] However, there were several studies that used other historical classifications. Taft et al included patients with Allman type III injuries, which are equivalent to Rockwood types III–VI.[19] Bakalim, Imatani, Rosenorn, Larsen, and Bannister did not use a formal classification system, but described complete AC separations equivalent to a Rockwood type III/V.[18–22] There were 8 studies that specifically looked at Rockwood type IIIs only, and 5 studies looking at Rockwood types III–Vs. There were a variety of operative techniques used. Operative management included the following techniques or implants: Phemister technique (K-wire),[20,21,23,24] Bosworth screw, Steinmann pin,[18,20,22,25–27] Weaver–Dunn,[28,29] hook plate,[5,7,30] direct coracoclavicular ligament repair,[6,31] and an arthroscopic-assisted TightRope procedure.[32] Nonoperative management included various techniques from skillful neglect, sling, taping or splinting, and physiotherapy. Follow-up ranged from 1 year to 19 years.

Meta-Analyses

The meta-analysis results are listed in Table 2. Functional outcome scores analyzed include the Constant Score and DASH (Disabilities of the Arm, Shoulder, and Hand) score. Five studies measured Constant Scores (Fig. 2). There was a statistically significant difference favoring the operative group (mean difference = 3.14; 95% CI: 0.27 to 6.02; P = 0.03). Three studies reported DASH Scores. There was no statistically significant difference between operative and nonoperative cohorts (mean difference = −1.97; 95% CI: −4.48 to 0.53; P = 0.12). No significant difference was found in Visual Analog Scales in 4 studies (mean difference = −0.38; 95% CI: −0.80 to 0.04; P = 0.07).

Other objective functional measures analyzed were time to return to work, return to sport, and time to pain-free status. Five studies measured return to work as the mean number of weeks off-work (Fig. 3). Patients who underwent nonoperative management returned to work a mean of 4.17 weeks quicker than the patients who had surgery (95% CI: 2.28 to 6.06; $P < 0.0001$). There was no statistically significant difference in return to sport in 2 studies (mean difference = 2.46; 95% CI: −17.04 to 21.96; P = 0.80).

Radiographic outcomes were also analyzed. The operative cohort was statistically more likely to have evidence of an AC joint reduction on x-ray in 8 studies (OR = 24.94; 95% CI: 5.89 to 105.71; $P < 0.0001$). Six studies evaluated for radiographic signs of osteoarthritis of the AC joint. No significant difference was detected between the operative and nonoperative groups (OR = 1.16; 95% CI: 0.31 to 4.36; P = 0.82). The MD for coracoclavicular distance was estimable in 2 studies. There was no statistically significant difference between the 2 groups (mean difference = −2.06; 95% CI: −4.53 to 0.40; P = 0.10).

Complications were reported in both the operative and nonoperative cohorts. Poor cosmetic outcomes included residual AC joint deformities and hypertrophic scars. Eight studies collected data on poor cosmetic outcomes (see **Figure**, **Supplemental Digital Content 3**, http://links.lww.com/JOT/A154, which displays the forest plot for cosmesis). This was significantly less likely in the operative group (OR = 0.05; 95% CI: 0.01 to 0.18; $P < 0.00001$). In 13 studies, implant complications were only found in the operative group (OR = 7.19; 95% CI: 2.89 to 17.91; $P < 0.0001$). Soft tissue complications ranged from infection (operative group only) to skin necrosis from tape or cast material (nonoperative group only). In 11 studies, these were significantly more likely in

TABLE 1. Study Characteristics and Patient Demographics

Study	Design	Sample Size, OP/NON	Age, y, OP/NON	Gender OP, M/F	Gender NON, M/F
Bakalim and Wilppula[20]	RC	19/22	N/A	N/A	N/A
Bannister et al[22]	RCT	27/33	32.5	N/A	N/A
Calvo et al[23]	RC	32/11	39.6/34.5	27/5	11/0
Cardone et al[31]	RC	6/8	29	6/0	8/0
COTS[5]	RCT	40/43	37.9/37.3	36/4	42/1
Esen et al[28]	RC	17/17	43.6	12/5	12/5
Fremerey et al[6]	RC	51/46	33.7/35.9	48/3	39/7
Galpin et al[25]	RC	16/21	28.9/36.7	N/A	N/A
Gstettner et al[30]	RC	24/17	37.2/36.2	25/3	20/2
Imatani et al[33]	RCT	11/12	24	11/0	12/0
Joukainen et al[24]	RCT	16/9	53/54	15/1	8/1
Larsen et al[21]	RCT	41/43	36/36	39/2	43/8
Macdonald et al[26]	RC	10/10	25/31.7	N/A	N/A
Natera Cisneros et al[32]	RC	20/21	36/38	17/3	18/3
Natera Cisneros and Sarasquete Reiriz[7]	RC	11/21	41/38	11/0	18/3
Press et al[29]	RC	16/10	30.7/49.6	12/4	9/1
Park et al[38]	RC	78/7	N/A	N/A	N/A
Rosenorn and Pedersen[18]	RC	11/13	37/41.5	8/3	12/1
Taft et al[27]	RC	52/75	N/A	N/A	N/A
Walsh et al[17]	RC	9/8	30.7/29.7	N/A	N/A

Study	Grade of Injury	Operative Management	Nonoperative Management	Follow-up, mo
Bakalim and Wilppula[20]	Complete loss of contact between clavicle and acromion	Phemister (K-wire) + CC ligament repair	Strapping of AC joint No PT	51.6
Bannister et al[22]	N/A	Bosworth CC screw	Sling for 2 wk PT	48
Calvo et al[23]	Rockwood type III	Phemister (K-wire)	Sling for 2 wk PT not specified	122.8 (OP); 40.5 (CON)
Cardone et al[31]	Rockwood type III	CC ligament repair	Sling PT	29.5
COTS[5]	Rockwood type III–V	Hook plate	Sling for 4 wk PT	24
Esen et al[28]	Rockwood type III	Modified Weaver–Dunn	AC bandage PT	33

TABLE 1. (*Continued*) Study Characteristics and Patient Demographics

Study	Grade of Injury	Operative Management	Nonoperative Management	Follow-up, mo
Fremerey et al[6]	Rockwood types III/V	CC and AC ligament repair	PT	72
Galpin et al[25]	Rockwood type III	Bosworth CC screw	PT	33.7
Gstettner et al[30]	Rockwood type III	Hook plate + CC ligament repair	Sling PT	36.8
Imatani et al[33]	Complete AC joint dislocation	Bosworth screw versus Steinmann pin	Velpeau bandage No PT	12
Joukainen et al[24]	Rockwood types III/V	Phemister (K-wire) + CC ligament repair	Splint for 4 wk No PT	228
Larsen et al[21]	Displacement greater than 75%	Phemister (K-wire) + CC ligaments repair	Sling PT	13
Macdonald et al[26]	Rockwood type III	Bosworth CC screw versus Steinmann pin	Sling or taping No PT	13
Natera Cisneros et al[32]	Rockwood types IIIB–V	Arthroscopic-assisted CC ligament fixation	Sling PT	24
Natera Cisneros and Sarasquete Reiriz[7]	Rockwood types III–V	Hook plate	Sling for 4 wk PT	33
Press et al[29]	Rockwood type III	Modified Weaver–Dunn	Sling PT	32.9
Park et al[38]	Rockwood type III	Dacron prosthetic reconstruction of CC ligament	Sling No PT	75.6
Rosenorn and Pedersen[18]	Complete displacement of AC joint	Bosworth CC screw	Bandage PT	12.25
Taft et al[27]	Allman grade 3	Bosworth CC screw versus Steinmann pin	Various methods including sling, splint, tape No PT	120
Walsh et al[17]	Allman grades 2–3	Dacron or Mersilene CC reconstruction versus Bosworth CC screw versus K-wire versus Knowles pin	Various methods No PT	33.4

CC, coracoclavicular; F, female; M, male; N/A, data not available; NON, nonoperative group; OP, operative group; PT, physiotherapy; RC, retrospective cohort; RCT, randomized control trial.

the cohort that underwent operative fixation (OR = 3.65; 95% CI: 1.43 to 9.32; $P = 0.007$). There was no difference in the rates of surgical intervention for failure of either operative or nonoperative treatment in 9 studies (OR = 1.08; 95% CI: 0.55 to 2.12; $P = 0.82$) (see **Figure**, **Supplemental Digital Content 4**, http://links.lww.com/JOT/A155, which displays the forest plot for failure of initial treatment).

Subgroup Analyses

A subgroup analysis of the 2 randomized control trials that reported Constant Scores did not show any significant difference (mean difference = 1.73; 95% CI: −3.78 to 7.24; $P = 0.54$) (Fig. 2). Likewise, there was no statistical significance with the 3 cohort studies with Constant Scores (mean difference = 4.71; 95% CI: −1.26 to 10.69; $P = 0.12$).

In the Rockwood classification subgroup analysis, there were 8 studies with isolated type III injuries and 11 studies with the equivalent of type III–V injuries. The statistical significance of the effect sizes in the III–V subgroup was concordant with the overall meta-analysis in all outcomes, except for the Constant Score (see **Table**, **Supplemental Digital Content 5**, http://links.lww.com/JOT/A156, which displays a summary of the Rockwood classification subgroup analysis). Unlike the overall meta-analysis, no significant difference was detected between operative and nonoperative cohorts in the III–V subgroup (mean difference = 2.52; 95% CI: −0.49 to 5.53;

TABLE 2. Summary of Meta-Analyses

Outcome	No. of Studies	Effect Estimate	*P*	Heterogeneity	
				I^2	χ^2
Constant Score	5	MD = 3.14 (0.27, 6.02)	0.03	0%	2.99 (*P* = 0.39)
DASH Score	3	MD = −1.97 (−4.48, 0.53)	0.12	0%	0.05 (*P* = 0.82)
Visual Analog Scale	4	MD = −0.38 (−0.80, 0.04)	0.07	12%	2.26 (*P* = 0.32)
Return to work, wk	5	MD = 4.17 (2.28, 6.06)	<0.0001	77%	17.31 (*P* = 0.002)
Return to sport, wk	4	MD = 2.46 (−17.04, 21.96)	0.80	89%	8.84 (*P* = 0.003)
Time to pain-free status, wk	2	MD = 0.52 (−3.28, 4.32)	0.79	0%	0.48 (*P* = 0.49)
Radiographic AC joint reduction	8	OR = 24.94 (5.89, 105.71)	<0.0001	71%	20.35 (*P* = 0.002)
Radiographic evidence of OA	6	OR = 1.16 (0.31, 4.36)	0.82	75%	19.86 (*P* = 0.001)
Radiographic coracoclavicular distance, mm	2	MD = −2.06 (−4.53, 0.40)	0.10	0%	0.27 (*P* = 0.61)
Cosmetic outcome	8	OR = 0.05 (0.01, 0.18)	<0.0001	53%	14.82 (*P* = 0.04)
Implant complications	13	OR = 7.19 (2.89, 17.91)	<0.0001	5%	11.58 (*P* = 0.40)
Infection/soft tissue complications	11	OR = 3.65 (1.43, 9.32)	0.007	0%	4.49 (*P* = 0.80)
Need for surgery for failure of treatment	9	OR = 1.08 (0.55, 2.12)	0.82	0%	5.74 (*P* = 0.68)

P = 0.10). The type III-only subgroup did show a significant difference in Constant Scores, favoring the operative cohort (mean difference = 9.70; 95% CI: −0.05 to 19.45; *P* = 0.05). However, there was only 1 study in this subgroup.

A summary of the subgroup analysis based on operative technique is listed in **Supplemental Digital Content 6** (see **Table**, http://links.lww.com/JOT/A157). A significant difference in Constant Scores favoring the operative group was seen only in 1 study that used an arthroscopic-assisted reconstruction of the coracoclavicular ligament (MD = 4.20; *P* = 0.01). The OR of implant complications was the highest in the Phemister (K-wire) subgroup (OR = 21.25, 95% CI: 2.68 to 168.59; *P* = 0.004). Statistical significance of the OR for soft tissue and infective complications was found in the Bosworth screw and hook plate subgroups (*P* = 0.02 and *P* = 0.04, respectively).

DISCUSSION

Controversy over management of high-grade AC joint dislocations has been reported in the literature for a number of decades. Previous meta-analyses have suggested that there is no benefit of operative intervention over nonoperative management in type III AC joint dislocations.[11,12] Anatomically, types IV and V injuries typically involve disruption of the deltotrapezial fascia. This may render the clavicle "irreducible" from its posterior or superior position, respectively.[3,25] Proponents for surgical fixation of types IV and V injuries recommend operative treatment for this reason. However, recent studies with validated objective outcomes suggest no difference in outcomes with nonoperative treatment.[5,6,22,24] Interobserver variability of high-grade dislocations is poor, and intraoperative findings of fascial disruption have not been found to correlate well with the degree of coracoclavicular displacement on preoperative radiographs.[25,33] As such, there has been a recent trend of studies considering Rockwood types III–V injuries as 1 cohort. No meta-analysis has previously analyzed all high-grade AC injuries.

Overall, the Constant Score favored the operative cohort over the nonoperative group by an MD of 3.14 points. However, the minimal clinically important difference for the Constant Score has been reported to be 10.4 points.[34] Thus,

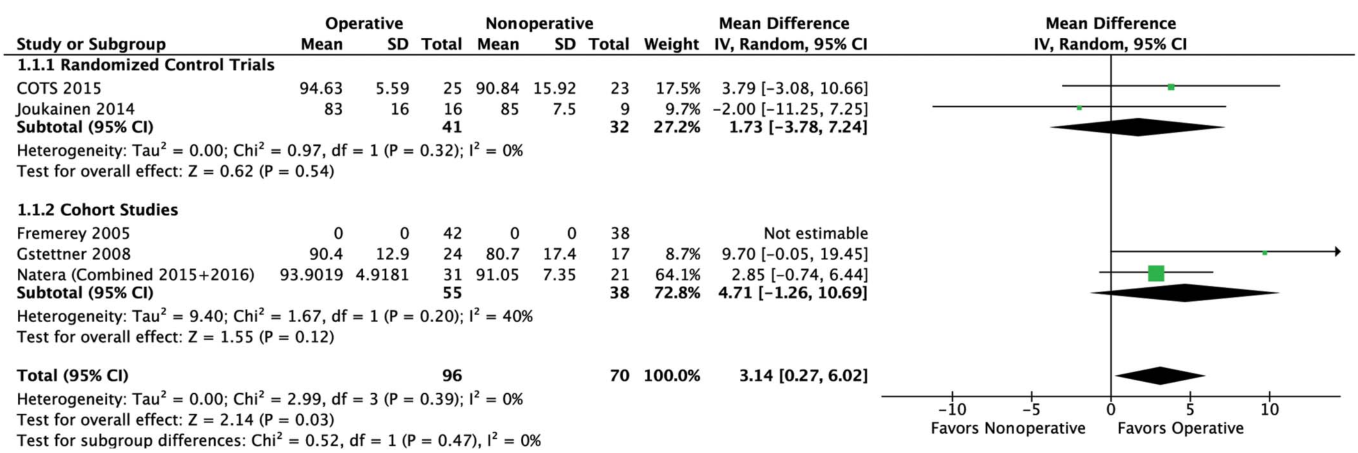

FIGURE 2. Forest plot demonstrating the difference in operative versus nonoperative management in Constant Score. Subgroup analyses were performed for randomized control trials and cohort studies. **Editor's Note:** A color image accompanies the online version of this article.

Study or Subgroup	Operative Mean	Operative SD	Operative Total	Nonoperative Mean	Nonoperative SD	Nonoperative Total	Weight	Mean Difference IV, Random, 95% CI
Bakalim 1974	12	3	19	5	3.5	22	21.6%	7.00 [5.01, 8.99]
Bannister 1989	11	0	0	4	0	0		Not estimable
COTS 2015	0	0	28	0	0	27		Not estimable
Fremerey 2005	7	2.7	34	3.7	2.3	33	25.5%	3.30 [2.10, 4.50]
Galpin 1985	6.8	0	14	2.6	0	19		Not estimable
Larsen 1986	8	5	39	6	3	40	22.5%	2.00 [0.18, 3.82]
Press 1997	11.3	8.675	16	3.5	4.325	10	9.4%	7.80 [2.77, 12.83]
Rosenorn 1974	9	2.25	11	6	2.75	11	21.0%	3.00 [0.90, 5.10]
Total (95% CI)			**133**			**135**	**100.0%**	**4.17 [2.28, 6.06]**

Heterogeneity: $Tau^2 = 3.27$; $Chi^2 = 17.31$, df = 4 (P = 0.002); $I^2 = 77\%$
Test for overall effect: Z = 4.32 (P < 0.0001)

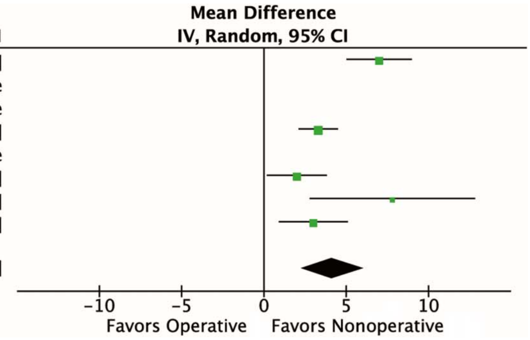

FIGURE 3. Forest plot demonstrating the difference in operative versus nonoperative management in time to return to work (weeks). **Editor's Note:** A color image accompanies the online version of this article.

despite its statistical significance in this meta-analysis, it is unlikely that there is a clinically detectable difference in function between the 2 cohorts. In addition, no difference in Constant Scores was found in either the subgroup analysis of the 2 randomized control trials. No difference was detected in the DASH Score, although there was a trend toward favoring the operative group. The COTS randomized control trial also reported no statistical difference between the 2 groups for Constant and DASH Scores at the 2-year follow-up.[5] However, the nonoperative group experienced a more rapid improvement in both functional scores. This was statistically significant over the first 6 weeks and 3 months, respectively.

The nonoperative cohort returned to work over 4 weeks quicker compared with the operative group. There is an associated socioeconomic benefit to this; however, a formal cost–benefit analysis will be required to measure the true effect. Only 2 studies had sufficient data to compare return to sport rates. However, the 2 studies have heterogeneous populations: the Cardone study featured professional Aussie rules football players returning to their sport, and the Press study analyzed normal people returning to their previous activity levels.[29,31] Individually, only the Press study was statistically significant and favored the nonoperative side. It also features a more generalizable sample cohort of the 2 studies.

Poor cosmetic outcome was seen in both operative and nonoperative groups, albeit for different reasons. Hypertrophic or prominent scars were the most common complaint in the operative group, whereas gross deformity of the shoulder was more prevalent in the nonoperative group. Overall, cosmetic outcomes favored the operative group. There was variability in how studies reported their cosmetic outcomes. Some study investigators attempted to objectively grade cosmesis. Other studies recorded this data subjectively and asked the patients to comment on the appearance of their shoulder. This is an important distinction to make, as the idea of a poor cosmetic outcome may vary from patient to patient. In addition, the appearance of a reduced AC joint, which favors the operative cohort, may not necessarily correlate with subjective cosmetic outcomes.

Surgical management inherently has more complications than nonoperative methods.[30] Implant complications and infections were only found in the operative group; however, Taft et al reported 2 cases of skin necrosis from nonoperative treatment.[27]

Revision rates for failure of treatment were also analyzed. Routine removal of implant cases was excluded. In the nonoperative group, only subjects who required delayed surgery after failure of nonoperative management were considered. Patients who were "cross-overs" in intention-to-treat analyses were excluded as failures.

Overall, 19 comparative studies were identified in our literature search. Systematic review of the articles revealed several methodological limitations. The majority of studies published on the subject are retrospective in nature. Only 5 of 19 studies in this systematic review had any semblance of randomization. Retrospective cohort studies have an inherent bias in patient selection when determining between operative and nonoperative treatment. Although it is not feasible to blind subjects to their intervention, only 1 study incorporated blinded assessors when collecting outcome data.[24] There is also a paucity of studies using validated outcome measures. Early literature on AC joint dislocations often used different subjective patient rating scales, which makes it challenging to make direct comparisons in patient outcomes between studies.[23,33] As such, we focused primarily on objective data and validated outcome scores.

The studies included in our systematic review and meta-analysis had a variety of different inclusion criteria. Eight studies recruited only patients with Rockwood type III AC joint dislocations. Eleven studies featured patients with the equivalent of a Rockwood type III–V injury. Because we included studies with isolated type III injuries only, this had the potential to confound our analysis of all high-grade injuries. The data extracted did not allow for subgroup analyses for each individual Rockwood type. However, a subgroup analysis was performed that separated the type III-only studies and the high-grade III–V studies.

Caution should be taken when interpreting the results of this subgroup analysis because of the fragmentation of data into smaller samples and the heterogeneity of study designs. Because the distribution of each Rockwood type is not known in the high-grade subgroup, an accurate comparison between the 2 subgroups is not feasible. Interestingly, the overall meta-analysis and the 2 Rockwood subgroups all failed to show a clinically significant difference in Constant Scores, as per the minimal clinically important difference.

Surgical management of high-grade AC joint dislocations has evolved over the years. There was a high heterogeneity between the studies for their operative techniques. Some of these techniques, including transarticular K-wires and coracoclavicular screws, are now considered suboptimal, given the undesirable rates of implant migration, failure, or fracture.[35–37] This was replicated in our subgroup analysis comparing each procedure type, where the odds ratios of implant complications were the highest in the Phemister (K-wire) and Bosworth coracoclavicular screw procedures. However, one should be wary of drawing too many conclusions from the operative technique subgroup analyses, as small subgroups with only 1 or 2 studies may be disproportionately weighted. In addition, 3 studies used multiple operative techniques, but reported their data as a single operative cohort. Recent arthroscopic-assisted techniques have shown favorable outcomes.[32] Further randomized control trials are necessary to measure their outcomes against the current standard of care. As the evidence base grows for managing high-grade AC dislocations, further analyses should be performed excluding outdated surgical techniques.

Few studies established a well-defined nonoperative protocol. Various immobilization techniques used included slings, bandages, or splints. Formal physiotherapy or rehabilitation was offered in 12 studies. However, there was little consistency regarding the onset, type, and duration of physiotherapy.

In conclusion, the results of this meta-analysis suggest that there is no clinical difference in functional outcome scores in high-grade AC joint dislocations. Patients who undergo nonoperative management have a more rapid return to work, but have a poorer cosmetic outcome of their shoulder. This highlights the importance of an informed discussion with the patient regarding the benefits and risks of both operative and nonoperative management.

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